AU/ACSC/0185/97-03

SPACE OPERATIONS FOR THE 21ST CENTURY

A FUNCTIONAL APPROACH

A Research Paper

Presented To

The Research Department

Air Command and Staff College

In Partial Fulfillment of the Graduation Requirements of ACSC

by

Major David R. Levy

March 1997

Report Documentation Page

Report Date	Report Type	Dates Covered (from... to)
01MAR1997	N/A	-

Title and Subtitle Space Operations for the 21st Century A Functional Approach	**Contract Number**
	Grant Number
	Program Element Number
Author(s) Levy, David R.	**Project Number**
	Task Number
	Work Unit Number
Performing Organization Name(s) and Address(es) Air Command and Staff College Maxwell AFB, Al 36112	**Performing Organization Report Number**
Sponsoring/Monitoring Agency Name(s) and Address(es)	**Sponsor/Monitor's Acronym(s)**
	Sponsor/Monitor's Report Number(s)
Distribution/Availability Statement Approved for public release, distribution unlimited	
Supplementary Notes	
Abstract	
Subject Terms	
Report Classification unclassified	**Classification of this page** unclassified
Classification of Abstract unclassified	**Limitation of Abstract** UU
Number of Pages 51	

Disclaimer

The views expressed in this academic research paper are those of the author and do not reflect the official policy or position of the US government or the Department of Defense.

Contents

Page

Tables

Page

Preface

Given the technological changes and recent revisions of Air Force vision and Global Engagement strategy, is the present Air Force doctrine and organizational structure for space operations appropriate for meeting the challenges of the Twenty-first Century? I wrote this paper to provide one set of views for addressing this question, with the intent to contribute insight into how to reorganize the military establishment to improve future military effectiveness and efficiency in space operations. The paper also contributes to the evolving debate over whether or not to create an independent U.S. Space Force, a debate which will probably not be silenced until such a service is formed—either as a break-off from the present services (as in the Air Force's history and envisioned by many space enthusiasts), or through a gradual metamorphosis of the US Air Force over the next fifty years or so (as intended by present Air Force leadership). In any case, space systems and the information they provide will continue to increase in importance for modern military powers, and the time will come when a disproportionate amount of resources will be devoted to military space endeavors.

I wish to thank my Major Peter Rogers, for his insightful comments and meticulous review of this paper. I also wish to thank the Institute for National Security Studies (INSS) (USAF Academy and AF/XOXI) for suggesting this topic as part of a Tier I Air Force planning issue.

Abstract

Present Air Force space doctrine and organizational structures are based on extrapolation of air power concepts. This has resulted in certain problems such as complaints of lack of warfighter support, unresponsive launch systems, and confusion over roles and missions like ballistic missile defense. The space community is also highly fragmented. Numerous agencies have been created recently to address some of these concerns, but these groups may just be adding to the lack of concentration of effort. Meanwhile, trends continue including the increased density and proliferation of commercial space assets through microminiaturization, reduced launch costs, and economies of scale, plus an increased dependency of US military forces on information from space-based force enhancement systems. This paper critiques present space doctrine and organization, looks at some trends and technologies as indicated in the *Spacecast 2020* and *New World Vistas* studies, and recommends doctrinal and organizational changes for more responsive space operations. Proposed are the space attributes of direct vantage, global access, endurance, and synchronization, and three space employment considerations of protection, standardization, and centralized space control. For organizing space forces, the acquisition, space control and apportionment of scare payload resources should be centralized in a single agency, but the operations of nonstrategic force enhancement space missions should be relegated to the joint warfighters.

Chapter 1

Introduction

. . . our most pressing challenge will be to explore the future aggressively, and to identify alternatives and opportunities for tomorrow's Air Force.

—Air Force Executive Guidance

Both the Joint Staff's *Joint Vision 2010* and the Air Force's *Global Engagement* mention *innovation* as the key to meeting future military challenges. For example, *Joint Vision 2010* states "[o]ur organizational climate must reward critical thinking, foster the competition of ideas, and reduce structural barriers to innovation."[1] Similarly, *Global Engagement* states "[t]he Air Force is committed to a vigorous program of experimenting, testing, exercising and evaluating new operational concepts and systems for air and space power. . . . We must reinvigorate the spirit of innovation and creativity that has long been the hallmark of the United States Air Force."[2] Because future threats will be diverse, and the level of technology accessible to adversaries will accelerate, while the resources available to modernize and sustain the U.S. military will in the best of cases be stable, innovation is seen as a method of leveraging those available resources to obtain the greatest benefit for meeting the challenges.

Although not specifically stated in the vision documents, the commitment to innovation should permit the services to turn any leap in technology into what Krepinevich identifies as a military-technology revolution (MTR), a term first used by the Russians to

identify fundamental transformations of warfare resulting from technological innovation.[3] Establishing an MTR requires the proper mix of doctrinal and organizational changes to fully exploit the emerging technology and turn it into a comparative military advantage. Krepinevich identifies information dominance and space control as two of ten possible missions which could be undergoing an MTR.[4] Given some of the statements made that Desert Storm was the first “space war” and/or “information war,” some readers may believe that the U.S. has already undergone an MTR in these areas. Indeed, *Global Engagement* adds space superiority and information superiority as two of the Air Force’s core competencies, suggesting that the service is committed to fully exploiting technological advances in these areas.[5]

Regarding military space operations, the key issue is whether in fact the U.S. military has the open-mindedness to fully take advantage of space assets and the information associated with them, thereby conclusively bringing about an MTR. The central thesis of this paper is the U.S. Air Force has not yet demonstrated sufficient originality in doctrine and organization to exploit space and emerging space-related technologies in a fully efficient and effective way. Present Air Force doctrine is stuck on the notion that air and space are just part of the same “continuum,” and therefore that the same principles of warfare apply to both, and that organizationally space can be handled similar to air, with a Numbered Air Force consisting of Space Wings centered around missions of space control, force application, and space support. The establishment of “battle labs” may permit the introduction of new tools, but unless appropriate doctrine and innovative organizational structures are also allowed to be changed, the Air Force will not be able to completely bring about the improvements outlined in its own vision statement.

To improve this situation, this paper first critiques present space doctrine and recommends some space attributes and employment considerations. It next looks at future trends for space systems, relying heavily on *Spacecast 2020* and *New World Vistas*. Finally, it combines the doctrinal assessment with the trends to suggest improvements in the organizational structure of the military space community.

Notes

[1] *Joint Vision 2010*, 23.

[2] *Global Engagement*, 9.

[3] Andrew F. Krepinevich, Jr., *The Military-Technical Revolution: A Preliminary Assessment*, OSD/Office of Net Assessment, July 1992,1.

[4] Ibid. The others are air control, sea control, sustained land operations, forcible entry, strategic strikes (on centers of gravity), strategic and theater defense, strategic mobility, and unconventional warfare.

[5] *Global Engagement*, 10, 14.

Chapter 2

Space Doctrine

The aerospace environment can be most fully exploited when considered as an indivisible whole.

—AFM 1-1, vol. 1

In spite of numerous articles and papers suggesting its illogic,[1] present Air Force doctrine on space operations is based on the notion that the same principles which apply to airpower also apply to space power. Indeed, the doctrine attempts to minimize a distinction between the two, preferring to use the term “aerospace,” often simply substituting that word in places where the doctrine used to say “air.”[2] Basically, the Air Force has an “airmindedness” mentality, which while being strategic in scope and not tied to the ground, is predominantly driven by tenets associated with systems that operate in an atmosphere, are manned, and are supported by ground bases at the end of the day. The main point of this section is that treating air and space as the same is a major error in thinking. This section discusses types of doctrine, why the present doctrine came about, summarizes the present official space doctrine and some counter arguments, and provides suggestions for improvement.

Types of Doctrine

Before going any further, the different kinds of doctrine should be discussed, so that one can define exactly what is meant by "doctrine." Drew and Snow maintain that there are actually three different kinds of doctrine: fundamental, environmental, and organizational.[3] Fundamental doctrine is timeless, relatively insensitive to technology and politics, applies to all mediums, concerns the basic nature of warfare, and is the foundation for the other two types. Environmental doctrine contains the beliefs of how best to employ forces in a particular operating medium, while organizational doctrine defines the beliefs associated with a particular military organization. Since the military services are broken up roughly by operating medium, the service-unique parts of each service doctrine can be considered both environmental and organizational. The problem regarding Air Force space doctrine is that the principles are derived from an air-based operational environment and force-fit to keep space within the constructs of the Air Force organization; thus, the doctrine is more reflective of an organizational doctrine than an environmental one.

Lupton divides historical thinking for space system employment into four belief structures or schools of doctrine, which will be referenced later in this paper. First there is the *sanctuary* school, which believes that the value of space systems lies in their legal overflight capacity; the benefits of this sanctuary should be preserved, so the U.S. should strictly abide by treaties and not plan for the presence of weapons in space. The second group is the *survivability* (or more accurately, vulnerability) school, which state that space systems are inherently less survivable than terrestrial forces, due to their designs and the lack of barriers or maneuverability to aid in protection; this school thus tends to avoid accomplishing critical functions in wartime with space systems. Next is the *high-ground*

school, which view the global presence characteristic as key for performing functions such as ballistic missile defense, provided weapons are used in space; space thus offers the promise of freeing the nation from the terror of enemy offensive strike capabilities. Lastly, the *control* school believes that whoever controls space controls whatever is beneath it, drawing parallels to sea and air control.[4]

Why Did This Doctrine Happen?

There may be several basic reasons for why the Air Force believes that the air and space media reflect the same tenets of warfare. First, a large number of the individuals who either write or approve the doctrinal statements are predominantly air power enthusiasts (pilots), so they do not have much operational experience in the space world and thus do not see where the old air principles do not apply. Supporting this notion would be the fact that the vast majority of senior military leadership in space fields are pilots—even among the leadership in their own Space Command. As shown in Appendix A, nine of the present sixteen U.S. flag officers in USSPACECOM/NORAD/AFSPC have the command pilot rating, while only three started out in the space career field.[5] By making air and space the same, the use of pilots experienced in air power can be rationalized for assignment to the space jobs. (However, to date it only seems to go in one direction—one does not see space operations officers commanding flying wings.) In an age of downsizing where the number of operational flying wings is continually reduced, the present system is a great advantage for the pilots as relatively more career and command positions become available to them. Furthermore, piloted spaceplanes may someday be developed, so why should they not be employed like airplanes?

Second, by making “aerospace” part of the Air Force’s mission, all the systems, personnel, support, and funding for the space systems should (at least in theory) be part of the Air Force bureaucracy. During the latest roles and missions review, the Air Force’s position was that they should be put in charge of all military space systems, a position which was successfully rebuffed by the Army and the Navy using the arguments that space systems support the ground and oceans as much as the air. Nevertheless, the Air Force controls a preponderance of military space assets, personnel and budget, as well as the entire military range, space surveillance, and spacelift support missions.[6]

Third, there is a possibility that further technological advances could someday make air power inferior to space power—a kind of high ground situation where the superior dwell and continuous global presence of space assets might be able to control whatever is “beneath” them. Traditionally, those airframes which could fly faster and further had the advantage in battle, so by extrapolation a transatmospheric vehicle (TAV)/spaceplane ought to have even more of an advantage. Additionally, a spaceborne directed energy weapon (e.g., high energy laser) which could penetrate the atmosphere could potentially have total control over whatever was beneath it—virtually an ultimate weapon limited only by the ability of planners to find the targets. By keeping the development of these technologies under the control of the Air Force, the occurrence of such a situation would not jeopardize the existing bureaucratic structure.

Lastly, there is the basic fact that space systems have not been around as long as air systems, and there are legal constraints like the Outer Space and ABM Treaties which prohibit the development or employment of certain systems in space. Consequently, there is a general lack of experience in the use or potential use of certain space missions. Joint

Pub 1 states that doctrine "provides the distilled insights and wisdom gained from our collective experience with warfare."[7] This definition is backward looking and suggests that without much experience, one could expect the doctrine to be immature. A battle lab employing simulation could help fill the void where a lack of technological, fiscal, or legal constraints have resulted in the certain systems not being employed. But then how does one validate the simulations?

Summary of Air Force Space Doctrine

As mentioned above, air and space are considered indivisible, so that the same time-honored principles that have historically applied to air also apply to space. AFM 1-1 describes two features which uniquely characterize the aerospace medium and bind it together: freedom of movement and elevation. The first feature is due to the fact that, "since the earth is entirely surrounded by air and space, all points on its surface are accessible from the aerospace environment."[8] The advantage of this third dimension is that ground obstacles can be overcome, as there are no physical barriers. Likewise, speed can be much greater. The second feature results because aerospace is a "continuum" that "begins at the earth's surface and extends upward toward infinity"; one just needs "more technologically advanced means" to reach the higher elevations, and trying to separate air and space is "equivalent to saying that submarines and surface ships should be in separate force structures."[9] Elevation provides the potential energy and observational advantages of the high ground much sought after by surface forces.

Given that air and space are considered the same operational medium for doctrinal purposes, AFM 1-1 then outlines principles of war, roles, and tenets of aerospace power; Essay J then defines characteristics, advantages, and capabilities (see Table 1)[10]:

Table 1. Summary of AFM 1-1

Principles of War	Roles	Tenets of Aerospace Power
1. Objective 2. Offensive 3. Mass 4. Economy of Force 5. Maneuver 6. Unity of Command 7. Security 8. Surprise 9. Simplicity	1. Aerospace Control 2. Force Application 3. Force Enhancement 4. Force Support	1. Centralized control/ decentralized execution 2. Flexibility/Versatility 3. Priority 4. Synergy 5. Balance 6. Concentration 7. Persistent
Characteristics of Aerospace Systems	**Advantages of the Vertical Dimension**	**Capabilities of Aerospace Systems**
1. Speed 2. Range 3. Flexibility	1. Perspective 2. Speed 3. Range 4. Maneuverability	1. Mobility 2. Responsiveness 3. Flexibility 4. Versatility

The Air Force, under the auspices of AFSPC/XP and HQ USAF/XOX, is presently developing a draft Air Force Doctrine Document (AFDD-4) applicable for space operations; various draft versions have been under review over at least the last five years, as a replacement for AFM 1-6 Military Space Doctrine (15 Oct 82). The most recent draft divides space force operations into four categories consistent with the four roles in AFM 1-1, but in place of the seven tenets the document lists five "attributes of space power"[11]:

1. **Global coverage—**frequent access to specific earth locations, including those denied to terrestrial forces, on a recurring basis. Unconstrained by political boundaries. Provides an instantaneous presence.

2. **Flexibility—**can adapt to new situations through on-orbit, real-time reprogramming, modifying terrestrial processing operations, and by modifying replacement satellites.
3. **Economy—**some functions are performed more economically from space, e.g., global communications and weather forecasting.
4. **Effectiveness—**absence of atmosphere and attenuation (for directed energy weapons); absence of atmospheric drag enables high velocities (for kinetic energy weapons).
5. **Robustness—**Functions accomplished both in space and in the terrestrial environment provide mutual backup.

It is not clear how these attributes will be rationalized against AFM 1-1, nor is it even certain that this document will be approved as presently drafted (or even at all). Nevertheless, it is promising that the attributes reflect an appreciation for some of the unique features of the space environment and the vehicles which operate within it.

One additional doctrinal effort, worth mentioning because it appears to recognize the uniqueness of space, is Joint Pub 3-14, *Joint Doctrine; Tactics, Techniques, and Procedures (TTP) for Space Operations* (15 April 1992 draft). For example, the document notes that one function of the DOD Space Policy is “to recognize space as a unique operating medium within which the conduct of military operations can take place, as on land, at sea, and in the atmosphere.”[12] The document then goes on to describe unique space characteristics and operational considerations, some which are referred to in this paper below. The authors apparently were not encumbered by organizational desires to have air and space an indivisible whole; perhaps this also helps explain why the document still remains a draft five years after its publication. Unfortunately, it also has a few comments that reveal that the authors still consider space in a predominantly support role; for example, it states that “[t]he ultimate objective of military space operations is the effective employment of space capabilities in support of land, sea and air operations to

gain and maintain a combat advantage throughout the operational continuum and across the three levels of war."[13] Perhaps the authors did not consider that space operations could someday make contributions independent of the ground, or be decisive by themselves. Nevertheless, this document is a good first step toward developing an environmental doctrine unique to the space medium.

The Fallacy of "Aerospace"

By looking at the characteristics of both the operational environment (space), and the forces that operate within it, one should be able to derive principles applicable for environmental doctrine, even without the benefit of operational experience in areas prohibited by treaty or constrained by technology. Several authors have pointed out the differences between space and air. Regarding the employment of space systems, these differences can be lumped into several categories: environmental, operational (especially maneuver), technological, and political.

Environmental

Myers and Tockston point out that the space environment differs from the atmosphere by the presence of orbital flight, a hard vacuum, a state of weightlessness, and an infinitely larger operating medium.[14] The orbital flight impacts the operational characteristics as described below, while the hard vacuum permits the propagation of unattenuated radiation. Weightlessness effects how the systems are built (historically fragile, not needing costly weight for stiffness on appendages) plus affects crew performance in the case of manned space flight operations.

Noyes points out two other features of space: (1) the nakedness of space, and (2) the sheer unlimited three-dimensional quality of space flight.[15] The first difference means that there is no place to hide in space—nothing like clouds or mountains to fly around. The second means that battles in space will be long-range affairs, with closure rates and changes in relative position slow with respect to reaction times. Both these features could be accounted for using intelligent design not yet used in practice today: stealth or deception to aid against the nakedness, and directed energy weapons or electronic warfare measures traveling at light speed to work the time-distance problem.

Joint Pub 3-14 (15 April 1992 draft) identifies seven physical attributes of the space environment: extent, vantage, gravity, composition, radiation, temperature, and propagation.[16] The characteristics of these attributes means that space systems will have different employment and technological aspects than terrestrial systems.

Operational

Lt Col Mantz points out that while there is no absolute boundary between atmosphere and space, each medium is governed by separate physical principles, which affect how vehicles operate within that medium:

> The dominant physical principles in the atmosphere are lift and drag, while in space they are orbital mechanics. You don't yank and bank in space. Airplanes cannot fly in space, though some may reach the edges of space. Spacecraft may pass through the air, but are usually not designed to fly there.[17]

Mantz further points out that while aircraft have maximum maneuverability, spacecraft cannot easily maneuver; major fuel expenditures are required for relatively small orbital changes. Thus, the principles of mass and maneuver apply differently:

> Aircraft can mass repeatedly through maneuver over a target while spacecraft can mass for short periods after great effort, but will disperse almost immediately with a repeat massing unlikely. Aircraft operations are "on demand," while current spacecraft operations are "as scheduled" or "when available."[18]

Using similar arguments, Col Middleton points out that motion of space assets is controlled by Kepler's laws of orbital motion, and consequently there is a severe restriction on "lateral movement." These laws also mean that satellite motion is fairly predictable, especially over short terms. On the other hand, space assets can remain at high velocities in space and remain in fixed positions (i.e., at certain locations like geostationary orbits or libration points), while aircraft in the atmosphere must continuously expend energy in overcoming friction and drag to stay at constant velocity or hover. Conversely, aircraft only need a relatively small amount of energy to perform perpendicular maneuvers or reverse direction, while even small perpendicular maneuvers by spacecraft "require such massive amounts of energy as to make them impractical."[19] Furthermore, such spacecraft maneuvers often require extensive planning time and the precision of computers to execute.

From a similar line of thought, Myers and Tockston suggest that the relevant characteristics for space systems are emplacement, pervasiveness, and timeliness, in contrast to those of speed, range, and flexibility as mentioned in AFM 1-1.[20] Emplacement comes from the fact that deployed satellites are normally mission ready to support military operations at all times. Pervasiveness means that space surrounds land, sea, and air, so that space forces have a constant (recurring or omni-) presence over any terrestrial location—denying the enemy surprise and sanctuary. Lastly, timeliness refers to

the fact that satellite operations utilize the electromagnetic propagation of signals, so that information can be available in near real time.

Joint Pub 3-14 (draft) recognizes seven considerations unique to space operations: difficult access, placement, long duration, maneuver, global coverage, decisive orbits, and weapons range.[21] Notwithstanding the possibility that difficult access may change as more responsive launch systems become available, and that decisive orbits may lose their decisiveness as networks of smaller satellites replace large stand-alone satellites, these considerations underscore the point that a particular mindset, or "space-mindedness," is valuable for fully appreciating the subtleties of space asset employment.

Clearly, the operation of satellites is different than that of aircraft, which makes AFM 1-1's analogy of comparing the relationship of aircraft with spacecraft to that of submarines with ships (which both float and move by propellers displacing water) to appear ludicrous upon closer examination. As satellites typically cannot be reconfigured to do greatly different missions once they are launched, and since they operate in specified orbits and normally are stuck with the payloads with which they were launched, their flexibility against changing mission requirements is limited. On-orbit retrofitting and servicing has historically been done at great expense only on high-value, one-of-a-kind resources like the Space Telescope, while the majority of militarily-useful mission orbits are likely to remain outside the bounds of Space Shuttle or TAV capabilities over the next two decades. Thus, a country should have already developed and either deployed or stored satellites to perform all the projected mission needs once a contingency starts.

Technological

Historically and for the immediate near-term, most space systems have been characterized by their complexity and cost. The complexity is due to the requirements to operate in a very harsh environment (e.g., vacuum, temperature cycling, particle bombardment) for a long time, and typically unattended. Only a small fraction of satellites are serviceable by the space shuttle, and the associated cost with on-orbit servicing is often too great as to make it more economical to launch a replacement satellite. To achieve long lifetimes, the spacecraft must either be built with much internal redundancy (and thus more weight and cost) and fuel for stationkeeping, or else be designed from the start as "disposable" with the reliability and fuel savings achieved through proliferation and economies of scale. Meanwhile, costs for getting payloads into orbit in the first place have been large, so fractional cost reduction has been the focus of recent program initiatives like the Evolved Expendable Launch Vehicle (EELV). Indeed, there is a tradeoff between the launch costs associated with adding weight associated with redundancy and fuel, versus the costs associated with having to launch replenishment satellites more frequently.

Many satellites have also been operationally demanding to control, relying on networks of ground stations for satellite tracking and stationkeeping, in addition to payload configuration management and health and safety monitoring. These demands have tended to create a reliance on dedicated ground station systems with specially trained ground crews and detailed procedures for handling most in-flight contingencies.

A last characteristic of space systems to date has been their fragility (reference the survivability school). In order to reduce weight and thus launch cost, only enough structure as is required to meet launch loads and/or payload stability stiffness requirements

is used. The trend is toward ever more exotic materials like metal-matrix composites and alloys. The entire structure is then typically covered with special thermal surfaces like multi-layer insulation blankets, optical solar radiators, or black paints, depending upon the aspect of the surface with respect to the sun. Energy sources for most missions involve solar arrays which by design have a large, open surface in order to maximize efficiency. Protection of satellites normally involves using only enough shielding to protect from the effects of charged particles and perhaps high electric fields (as may be associated with the upper regions of the atmosphere, the van Allen belts, solar flares or perhaps even high altitude nuclear bursts). Electronic and optical components may also be protected against specific electromagnetic threats, but in general satellites are not built with armor or sufficient shielding to survive direct kinetic or directed energy attacks or nearby nuclear bursts. Such design approaches have been sufficient to date because the threat level for these attacks has been minimal, but this could change over the next thirty years as adversaries further develop threatening technologies.

Future trends promise to mitigate the complexity, cost and operational demands associated with space systems, and indirectly lead to less fragile (or more easily replaceable) systems. Newer, hopefully cheaper, launch vehicles should be available, while widespread "dual use" of commercial satellite and booster technology should improve economies of scale. Meanwhile, the continuing trend toward micro-miniaturization of electronic and mechanical components will allow for more mission and/or redundancy for a given payload weight, and the emergence of microsatellites will permit the deployment of networks of hundreds or thousands of satellites on just a few launches. Smarter, faster on-board computers will permit a tremendous amount of satellite autonomy, significantly

simplifying ground operations. Finally, a more lasting manned space flight presence associated with the Space Station or a manned spaceplane may bring about additional opportunities for on-orbit assembly, resupply, repair, retrieval, and on-orbit manned mission operations.[22]

Political

The political differences between the space and air concern the fact that space is considered a sanctuary free of political boundaries and thus not owned by any one nation. This "open skies" policy means that no prior approvals are required to overfly another nation's territory, and these guarantees are part of international law. These considerations thus may make it more desirable to perform certain military operations from space, especially in situations where an uninvited air, sea or land intrusion would have political consequences if detected. This concept supports the sanctuary school.

However, the political situation is beginning to change as space becomes more congested, and since history shows that war can follow conflict, prudence would dictate that preparations be made to assure that our most vital space assets are protected from attack once conflict extends to space. In addition to concerns of collision avoidance in low-earth orbits, nations are competing for frequency allocations and orbital slots for a multitude of communication systems. Already orbital slots in the geosynchronous orbital belts must be registered, with disputes arbitrated for minimizing interference. In a future characterized by more and more space systems, these disputes can be expected to increase, perhaps leading to a situation of electronic or even physical combat against interfering satellites. Space terrorism may also become a reality as access to space becomes more readily available to third parties and the development of dumb

fragmentation (or possibly even nuclear burst) weapons becomes available to those with sufficient financial resources. Finally, other nations may simply want to deny the U.S. the benefit of our own space assets should an armed conflict evolve—and it may be much cheaper to *deny* an opponent access to space than it would be to *control* the use of it.

Problems with Bad Doctrine

The biggest problem with the present Air Force doctrine is that the rationale has little to do with the physics involved, a physics that drives space systems to have different physical, functional and even legal characteristics than air systems. The differences and unique features are minimized in relation to the features of elevation and freedom of movement, resulting in an employment doctrine that leaves space operations to be chained to the lessons of airpower. Thus, the personnel operating space systems may not appreciate some of the operational limitations not shared by aircraft. For example, Middleton notes that only on-orbit assets should be expected to provide space support of near-term operations, due to the current long response launch times associated with today's boosters.[23] Similarly, personnel may not appreciate advantages of space systems, missing opportunities or putting priority on the wrong systems.

Another problem is that the services organize around their doctrinal concepts. For example, each Space Wing is centered around one operational mission, like spacelift, space surveillance, or space operations. If the doctrine is wrong, the organizational structure then becomes less effective at meeting the warfighters requirements.

Recommendations for Improvement

Clearly, speed, range, and flexibility apply to airpower, but are not the defining characteristics of space systems. As mentioned above, the new AFFD-4 suggests the following attributes of space power: global coverage, flexibility, economy, effectiveness, and robustness. Given the historically high cost of space systems, it is a reach to say that a principle of economy applies. This high cost also has limited the proliferation of satellites, so the limited numbers combined with their fragility could hardly be an indication of robustness. On the other hand, Myers and Tockston propose emplacement, pervasiveness and timeliness. Friedenstein has analyzed the tenets of aerospace power as reflected in the original 1982 AFM 1-6, which are roughly similar to the tenets in AFM 1-1; his position is that while the principles of objective, economy of force, and control apply equally to space as air, the principles of security, surprise, timing, and tempo apply in a much different fashion, while the principles of concentration, flexibility/maneuver, and simplicity do not apply.[24]

Keeping in mind that space technology will continue to advance bringing about such capabilities as microsatellites, space weapons, TAVs, on-orbit refurbishment, and much easier access to space, the following space attributes are proposed:

1. **Direct vantage—**with proper orbit selection, satellites can obtain line-of-sight to any location on the earth. The use of networks of satellites can create an instantaneous (or near-instantaneous) access on demand, while radar can penetrate clouds, darkness, and even some covers. An adversary will need to employ countermeasures in order to avoid detection and targeting by an eye in the sky.
2. **Global access—**Spacecraft move in orbits, so with a few exceptions (e.g., geostationary and libration points) satellites fly around the earth, and are not confined to a particular regional area of responsibility.[25] This global nature means that space systems have an inherent strategic character, and protecting them requires a strategic outlook.

3. **Endurance—**Once in orbit, space systems generally stay there, with minor corrections for stationkeeping. Air systems require fuel to stay aloft, and even with in-air refueling missions are limited to hours due to flight crew limits. Space system "sorties" last weeks to years, not hours.
4. **Synchronization—**to reduce shortcomings in revisit rate or dwell times associated with particular orbits, space systems are best operated in constellations or networks. The positioning and phasing of the individual elements are tightly controlled in order to maximize the overall mission performance, and once in position, significant changes are difficult, expensive, or even impossible due to maneuver fuel requirements. Synchronization thus requires careful, specialized mission planning and precise deployment within "launch windows." Aircraft can fly in formation if tactics dictate that such operations improve mission effectiveness, but they can just as easily be assigned independent operations, and can take off any time of the day. Spacecraft do not have this flexibility or maneuverability.

The following employment considerations are particularly pertinent for space systems:

1. **Protection—**the general fragility of spacecraft make space denial more powerful than space control. An adversary with rudimentary electronic warfare or space launch capability can disrupt or destroy friendly assets more easily than it takes to deploy those assets, especially against low-cost commercial systems that have limited built-in survivability. Orbital mechanics also aids an adversary in predicting the location of space assets at future times for targeting. Thus, a premium on defensive measures such as encryption, proliferation, deception/concealment, and rapid replenishment is required. Armor may even be needed, as well as offensive counterspace operations as the ultimate method of assuring space control. *Protection must be an inherent design consideration for systems upon which friendly forces are highly reliant*.
2. **Standardization—**commonality and standardization are the keys to developing a robust space force, something that is only beginning to be learned by the military space community. Historically, each spacecraft mission had its own dedicated spacecraft, payload, and launch system requirements. This approach has been extremely expensive with minimal chances for economies of scale. Even worse, this approach reduces the responsiveness as each dedicated system takes a long time to acquire, deploy, and replenish. Additionally, the ground stations have become dedicated "stovepipes" which typically operate only one system—not very flexible or robust to outages. By using standardized practices and interfaces, the spacecraft, launchers, and ground station support can become more economical, responsive and robust. As will be seen in the next chapter, the commercial industry is moving rapidly in this direction.
3. **Centralized space control—**this tenet from air power also applies to space power, as space systems are synergistically operated when orchestrated by a central authority. This authority will also apportion scarce payload resources

> among multiple users worldwide, will manage space traffic (including debris avoidance and RF interference mitigation) as it becomes increasingly dense, and will monitor the space order-of-battle to detect threats and perform the space control function. As with air control, space control assets are most effectively implemented when coordinated to achieve synergistic effects. Individual satellites can be operated by either centralized or decentralized execution, although the constellation integrity must be maintained. Space weapons employment should likewise be centrally controlled as long as those assets are in limited supply. On the other hand, the users, operators, and deployers of particular force enhancement space systems need not be centralized, as doing so can reduce the effectiveness of warfighter support. In fact, using a central body for operating a rapidly expanding number of force enhancement space vehicles (or even commercial satellites) dilutes the focus from the space control mission and puts a split between the operator and the user of a satellite system.

Given the changing post-Cold War strategic environment characterized by more a broader spectrum of threats, with the bulk at the lower intensity scale, the characteristics of direct vantage, global access and endurance make space systems an ideal tool for complementing other military means. Weapons in space will then exploit the global access as a means for performing a "space occupation" to enforce terrestrial conditions on enemy territory.

Notes

[1]Noteworthy articles include Lt Col Charles D. Friedenstein, "The Uniqueness of Space Doctrine," *Air University Review* 37, no1 (November-December 1985), 13-23; Col Kenneth A. Myers and Lt Col John G. Tockston "Real Tenets of Military Space Doctrine," *Airpower Journal*, Winter 1988, 55-68; and Col Gordon R. Middleton, *Space is a Different Place,* Air War College report (Maxwell AFB, AL: Air War College, 5 May 1992), 2-3.

[2]For an in-depth historical accounting of the word "aerospace" in official Air Force doctrinal works, going back to General Thomas D. White's introduction of the term in 1958, consult Friedenstein, 14-17.

[3]Col Dennis M. Drew and Dr Donald M Snow, *Making Strategy: An Introduction to National Security Processes and Problems* (Maxwell AFB, AL: Air University Press, August 1988), 167-170.

[4]Lt Col David E. Lupton, *On Space Warfare: A Space Power Doctrine,* (Maxwell AFB, AL: Air University Press, 1988), 35-37.

[5]Data taken off fact sheets 28 February 1997 on-line the Internet: http://www.spacecom.af.mil. Note that 3 of the officers started out as missileers, which is

consistent with a Nov 1996 policy memo by AFSPC/CC encouraging maximum crossflow between the space and missile career fields. Evidently, the commander believes that missile and space operations are suitably similar to make this crossflow desirable. Since AFSPC contains two numbered air forces (NAF), the 14AF (space) and 20AF (missiles), this policy assures career broadening throughout the command. If the two NAF were in separate commands, would such crossflow still be desirable from an employment and efficiency standpoint?

[6]In 1995, the Air Force controlled approximately 80 percent of the military space budget and 95 percent of the personnel to perform DOD space operations. See "Coherent Space Programs Aim of Joint Service Push," *National Defense*, January 1995, 12.

[7]JCS Pub 1, *Joint Warfare of the Armed Forces of the United States*, 10 January 1995, vi.

[8]Air Force Manual (AFM) 1-1, *Basic Aerospace Doctrine of the United States Air Force*, vol. II, March 1992, Essay H, 66.

[9]Ibid., 66-7.

[10]AFM 1-1, Vol. I, 1,7,8 and Vol. II, Essay J, 79-83.

[11]Air Force Doctrine Document (AFDD) 4, *Space Operations Doctrine*, 10 July 1996 (Draft), 10-11. This document is also referred to as AFDD 2-2. The previous draft version dated 1 December 1994 listed these tenets of space power: space superiority, centralized control/decentralized application, synergy, presence, and balance.

[12]JCS Pub 3-14, *Joint Doctrine: Tactics, Techniques, and Procedures (TPP) for Space Operations*, 15 April 1992 (Draft), I-15.

[13]Ibid., III-3.

[14]Myers, 59.

[15]Harry F. Noyes III, "Air and Space Forces: The One Endures as the Other Emerges," *Airpower Journal*, Spring 1990, 69.

[16]JCS Pub 3-14, II-3-II-7.

[17]Lt Col Michael R. Mantz, *The New Sword: A Theory of Space Combat Power* (Maxwell AFB, AL: Air University Press, May 1995), 79.

[18]Ibid., 79-80.

[19]Middleton, 2-3.

[20]Myers, 59.

[21]Joint Pub 3-14, II-8-II-12.

[22]Bruner contends that a reusable launch vehicle (RLV), with an attendant orders-of-magnitude reduction in launch costs, could produce a "space operability revolution" enabling "timely logistic resupply, rapid maneuverability, and on-scene human judgment." See Maj William W. Bruner III, "National Security Implications of Inexpensive Space Access," SAAS report (Maxwell AFB, School of Advanced Airpower Studies, June 1995), 35.

[23]Middleton, 6.

[24]Friedenstein, 17-21.

[25]Depending upon the orbital parameters, especially the inclination (the angle of the orbit's plane with respect to the earth's equator), some spacecraft might not directly

overfly the greater latitudes; however, most typically will have line-of-site vantage to most points on earth, at angles off from the nadir. The orbital parameters can be selected to obtain the best mix of revisit time, slant range, and dwell time for a particular mission over particular coverage areas on the earth. Geostationary orbits represent a case where coverage of half the earth is traded off in order to have continuous dwell over the accessible hemisphere. Using constellations is one way to reduce shortfalls in dwell or revisit associated with individual satellites.

Chapter 3

Trends in Space Systems

*We are now transitioning from an **air** force into an **air and space** force on an evolutionary path to a **space and air** force.*

—*Global Engagement: A Vision for the 21st Century Air Force*

Some of the same arguments used by airpower advocates to gain an independent U.S. Air Force can be similarly applied to today's debate over whether or not to create an independent Space Force. But just because space requires a different environmental doctrine, does it require a separate operational one? To help answer this question, this section will look at some future trends of space systems, in order to develop a list of the major functional requirements for the future military space capabilities. The optimal space organizational structure should then correspond to the major functions required.

The discussion in Chapter 2 briefly highlighted some of the major trends in space systems. One source for these trends is the *Spacecast 2020* study performed by 114 Air University (AWC/ACSC) students during the 1993-94 academic year. However, some of the results take an airpower flavor (the number one leveraged system is a spaceplane), which should not be surprising since 30% of the participants had pilot/navigator/missile operations backgrounds, while only 4% of the participants had space operations backgrounds.[1] Nevertheless, the results illuminate one set of ideas on where the technologies are headed and which systems will provide the most leverage (see Table 2).

Table 2. Spacecast 2020 Systems and Technologies

System Identification	Technology Identification
1. Refueled Trans-Atm Vehicle (TAV)	1. Data Fusion
2. Orbital Transfer Vehicle (OTV)	2. Electromagnetic Communications
3. Orbital Maneuvering Vehicle (OMV)	3. Energetic Materials
4. Space Modular Systems	4. Hard Real-Time Systems
5. Global Surv., Recon & Tgt Sys (GSRT)	5. High Energy Laser Systems
6. Super Global Positioning System	6. High Performance Computing
7. Space Traffic Control System	7. High Power Microwave Systems
8. Weather Forecasting System	8. Image Processing
9. Sp-based Solar Mon & Alert Sat Sys	9. Information Security
10. Ionospheric Forecasting System	10. Kinetic Energy Systems
11. Holographic Projector	11. Lasers
12. Sp-based High Energy Laser System	12. Liquid Rocket Propulsion
13. Kinetic Energy Weapon System	13. Materials Technology
14. High Powered Microwave System	14. Micromechanical Devices
15. Particle Beam Weapon System	15. Nav, Guidance, and Vehicle Control
16. Weather C3 System	16. Neutral Particle Beam Systems
17. Solar Mirror System	17. Nonchemical/High Isp Propulsion
18. Asteroid Detection System	18. Optics
19. Asteroid Negation System	19. Power Systems & Energy Conversion
	20. Pulsed Power Systems
	21. Robotics, Controllers, & End Effectors
	22. Sensors
	23. Spacecraft Structures
	24. Vehicle Survivability
	25. Virtual Reality

Source: Spacecast 2020 Vol 4—Operational Analysis, 9-13.

Of the systems identified, items 1-4 concern space deployment (spacelift), items 5,6,8,16,17 concern enhancing terrestrial activities, items 7,9,10,11,18 concern on-orbit space support, and items 11-15,19 deal with space weapons (force projection/space control). The identified technologies support the various systems or improve the efficiency of existing operations.

Clearly, getting payloads or replacement parts to their proper orbits is the top priority for this study, but such systems actually represent only the spacelift function of the space support role. Deployment only represents the front end of military space operations, and

it is unclear whether this function needs to be militarized in the first place. Alternate launch means (e.g., air- or sea-launched rocket motors, cheaper land-based expendable launchers, even rail guns) could become viable, and may likely be more cost effective than spaceplanes or reusable OTV/OMVs. Indeed, OTV/OMVs could be made obsolete should breakthroughs occur in the nonchemical propulsion schemes (technology 17). Meanwhile, the commercial world is pursuing micro-miniaturization (technology 14) in order to deploy hundreds or thousands of microsatellites or nanosatellites without extensive launcher infrastructure.[2] Therefore, it is unclear why spacelift should remain the central focus of military space forces, and it remains to be seen whether TAVs will ever have sufficiently large payload masses (after accounting for the multiple engines required to operate in multiple media) to reduce costs to the point where they provide the method of choice for access to space.

Beyond spacelift, the next priority systems concern enhancing terrestrial operations, especially in the area of global surveillance, reconnaissance and targeting (GSRT). A JSTARS-like system in space would give warfighters on-demand situational awareness against any exposed terrestrial location, thereby significantly contributing to information dominance. This system would be the front end of any weapon system, whether it be vectoring land, sea, or air forces, tasking ballistic missile, air or space defense systems, or providing strategic warning for the employment of nuclear arms. At the same time, more traditional force enhancement missions should continue including navigation, weather, and communications support. All this information supports all geographic CINCs as well as CINCSTRAT and CINCNORAD, so limited data collection resources would have to be

apportioned and centrally controlled. But beyond this resource allocation, these missions could just as easily be performed by the warfighters they support—i.e., the end users.

The (on-orbit) space support and control functions are truly unique to a space command, especially those dedicated to the observation and control of the space order of battle. As space becomes increasingly congested, a traffic cop system will need to be institutionalized including an enforcement mechanism which does not presently exist. Today, the U.S. has worldwide networks of space surveillance and satellite control stations; in the future, these functions could be performed via on-orbit surveillance and control assets (e.g., item 7). An expanded Global Positioning System (GPS) could even permit autonomous ephemeris updates permitting hands-off stationkeeping. In wartime, the space support functions could be augmented with classified war mode and/or counterspace capabilities to prevent enemy denial activities against friendly space assets.

The last group of systems involve the placement of weapons in space, something which is presently against national policy and international treaty. As stated previously, there is no guarantee that rogue states or even non-state actors will not obtain the capabilities to employ simple space denial weapons ranging from ground-based jammers to on-orbit fragmentation weapons. Even more harmful would be a high-altitude nuclear burst from a ballistic trajectory. Once other parties are known to have these capabilities, it will be incumbent upon the U.S. military to develop space control systems capable of negating the adversary's denial capability; the "guarantees" of free access to space, as pushed by the sanctuary school and codified by treaties, mean little without enforcement mechanisms (an analogy would be the guarantee of free international waters to all nations). It may also be desirable to deploy ballistic missile defense systems in space to

improve the probability of interception; these weapons would also act as space control assets.

Of all the technologies listed in *Spacecast 2020*, the author believes micro-miniaturization (tech 14) and high-energy lasers (tech 5) have the greatest potential for revolutionizing warfare in the next century. Micro-miniaturization will solve the space access problem for a multitude of users, decreasing reliance on expensive boosters and highly complex, redundant space hardware. But such proliferation will also lead to additional space crowding with more emphasis on collision avoidance and space traffic control to avoid interference. Meanwhile, directed energy weapons will permit real-time destruction of detected targets. The new tactic for all terrestrial systems will be to avoid detection by the enemy, because detection means destruction. Thus, large, highly capable battle platforms (e.g., M1 tanks, F15 fighters, aircraft carriers) will become less relevant in place of smaller, covert or stealthy assets. Eventually all the services will desire directed energy weapons, but only those controlling the space medium will possess the characteristic of global line-of-sight vantage.

A similar study called *New World Vistas: Air and Space Power for the 21st Century,* was conducted in 1995 by the USAF Scientific Advisory Board. This study differed from *Spacecast 2020* in that data was chiefly collected by recognized experts outside the military, (i.e., in government, industry, and academia), and because it also included trends in any systems which support air and space power. Regarding the exploitation of space, *NWV* developed four themes needed to maintain military superiority: global awareness, knowledge on demand, space control, and force application.[3] These capabilities will result

from new systems provided sufficient investment is made in specific technological areas, as summarized in Table 3.

Table 3. NWV Recommendations for Investment in Space Technology

Revolutionary Technologies	Evolutionary Technologies	Commercial Technologies
1. High energy density chemical propellants 2. Lightwt structures for responsive, reusable launch capability 3. High-temp materials 4. High-performance maneuvering technology (electric & tethers) 5. Technology for high power generation	1. Launch vehicle technology 2. Satellite bus technology 3. Sensor technology 4. Communications technology 5. Data fusion technology, Auto tgt recognition 6. Space-based weapons technology 7. Laser weapons technology 8. Techn. for smart interceptors 9. RF weapons technology	1. Small launch vehicles 2. High-efficiency energy conversion & storage 3. High-data-rate RF communications 4. Debris reduction techn. 5. Info storage, retrieval & processing 6. Image processing, coding, compression, & VLSI arch. 7. Neural networks & artifical intelligence 8. Technolgy for space manufacturing 9. Techn. for vehicle and spacecraft operations

Source*: NWV*, Space Technology Volume, x-xii.

All these technologies are comparable to the *Spacecast 2020* technologies in Table 2, but they are separated by category to help the Air Force focus on where to spend its money. Minimal government funding is needed for the commercial technologies, although they "will result in standardized, modular bus designs that can be launched on any compatible launch vehicle, simplified payload designs, commoditized payload elements, and efficient (e.g., autonomous) operations."[4] Along with cheaper and more efficient boosters, the standardized, simplified, and miniaturized spacecraft should greatly expand access into space by all parties in the next century.

Notes

[1]Air University, *Spacecast 2020: Air University into the Future. Vol. 2—The Spacecast 2020 Process* (Maxwell AFB, AL: Air University, 22 June 1994), 4.

[2]Ernest Y. Robinson, Henry Helvajian, and Siegfried W. Janson, "Small and Smaller: The World of MNT," *Aerospace America*, 34, no 9 (September 1996), 26-32. NASA has also initiated a microsatellite technology development program under its New Millenium Program; on-line, Internet, 15 February 1997, available from http://www.nmp.jpl.nasa.gov.

[3]USAF Scientific Advisory Board, *New World Vistas (NWV): Air and Space Power for the 21st Century*, Summary Vol. (Washington DC: USAFSAB, 1995), 57.

[4]*NWV*, Space Technology Volume, 6.

Chapter 4

Organizational Structures

Because military space forces provide worldwide warfighting support, they are best organized on a functional basis.

—Joint Pub 3-14 (Draft)

Present Space Organizations

The present military space community is highly fragmented, in spite of the existence of USSPACECOM as the warfighting element. First, a large number of national space systems which at least partially support the military are acquired and operated under the National Reconnaissance Organization (NRO), outside the realm of the space commands or materiel commands. Second, system planning and budgeting is accomplished via a plethora of agencies, including: the three service component space commands; each service staff at the Pentagon; OSD/Acquisition Technology; Program Executive Officer (PEO) Space; Air Force and Navy materiel command product centers and labs; a Space Warfighting Center (SWC); an Army Space and Strategic Defense Command; a Navy Space and Naval Warfare Command (SPAWAR); a Space Architect office in Washington; a Joint Space Management Board; and DISA for space communications. Indeed, rather than have USCINCSPACE organize coordination, the Air Force recently praised itself for the creation of yet another agency to perform interagency space coordination, under a new

Deputy Undersecretary of Defense for Space (DUSD/Space). Third, the missile defense missions fall under an ad hoc agency called the Ballistic Missile Defense Organization (BMDO), the successor to the Strategic Defense Initiative Office (SDIO), rather than underneath one of the existing warfighting commands like USSPACECOM or USSTRATCOM.

With all these different agencies speaking for space planning and having different effects on parts of the military space budget, it is no wonder that decisions are inconsistent and subject to bureaucratic rather than operational considerations. The result? The warfighters in the field do not always get the support they need, as was seen in the case of communications support in Grenada or intelligence support in Desert Storm. Additionally, systems do not interoperate, facilities and staffs are duplicated, and economies of scale are not realized.[1]

One reason for confusion stems from the fact that unlike that of most air and naval systems, the operator of many space systems (e.g., AFSPC) is typically *not* the user. Instead of allowing each warfighting CINC control over those assets which directly support him, Space Command acts as a go-between to provide a service—one that could be performed wherever a ground station was located. Today, this system works well in minimizing the number of ground stations required for performing tasking and health and safety monitoring. However, extra bureaucracy, coordination, and communication is required, and mission data not directly downlinked to the field may be filtered, delayed, or cut off, causing the tactical warfighting commander not to rely on space systems as much as his or her own organic assets. Thus, while the space community is highly fragmented, space operations still appear to the tactical warfighters to be highly centralized.

Daehnick identifies two ways to organize military space architectures: "command-oriented" and "demand-oriented."[2] Command-oriented systems, which make up today's current architecture, are highly centralized and emphasize performance requirements; this leads to "small numbers of large, complex, high performance, and long-lived satellites" with operations for each mission run by functional "communities" in centralized "stovepipes."[3] There are numerous coordination and oversight committees and highly-compartmented security systems, with access to those outside the functional communities (e.g., the geographic CINCs) being difficult. Indeed, Butterworth maintains that the majority of the satellites supporting the tactical users were actually designed, built, and operated for other reasons, such as strategic intelligence, commercial telecommunications, and remote sensing.[4] To improve responsiveness, Daehnick proposes a shift to a demand-oriented architecture, characterized by "relatively larger numbers of smaller, more autonomous, specialized, and short-lived satellites deployed in constellations that could be tailored to specific situations."[5] The main features of this new architecture would be responsiveness and flexibility; command and control would be decentralized to a degree that those in the field could directly task and receive information from the spacecraft. Since the trends suggest a future characterized by an explosion of smaller, cheaper, standardized, more autonomous spacecraft with ready access to space, Daehnick's demand-oriented architecture fits perfectly for the majority of force enhancement missions not requiring centralized control and unity of command.

Proposed Space Organizations

The author proposes to combine the numerous space acquisition agencies into a single agency or service responsible for the requirements generation, budgeting, acquisition, deployment, and logistical support of military space systems. Since the role of the services is to train, organize and equip, this entity would rightly fit as an independent Space Force. This new organization should be composed of officers and professional civilians who have that "spacemindedness" mindset not developed from air operations. For example, if robotics systems and virtual reality can perform missions with less cost or performance degradation than manned systems (due to perhaps acceleration limits or excessive life support system overhead), then the agency should continue to invest in unmanned spacecraft. On the other hand, if manned spaceplanes revolutionize access to space, then the astronaut corps who best understand the new mission profiles should run the show. A single service is also much more likely to enforce standardization on hardware and signal interfaces, even when the end user resides within one of the terrestrial services. Any alternate approach requires the establishment of a multitude of committees and working groups to accomplish the same goal in a much less efficient manner, as is the case today.

Ballistic missiles could also be placed in this new service or agency, as their characteristics and control are more akin to boosters launching satellites than the aircraft making up the bulk of the Air Force. The present CINCSPACE would concur with this approach, since he has been trying to increase the cross-flow between the missile and space operations career fields.[6]

This agency could (preferably) be a separate independent Space Force, but could just as well be a part of Air Force provided that the space operations, doctrine, budget, and

personnel be kept distinct from the airbreathing community—in an analogous fashion to how the Army Air Corps was distinct, yet still a part of the U.S. Army. The upper leadership of this "Air Force Space Corps" should be predominantly astronauts, space operators, missileers, missile defense specialists—people who know and understand space employment concepts, not airfighting. Unfortunately, this approach goes against the present Air Force vision of trying to reduce, not add, functional stovepiping (even though the pilots still continue to exclusively run the air wings), and the creation of a common vision of an "airman."

Space operations should remain in an operational command (like USSPACECOM) provided they are dedicated to the space control and force application missions, along with a resource allocation section for centrally apportioning payload resources for those force enhancement missions that have limited assets. Beyond that, it makes little sense to retain control over the operation and processing of data associated with force enhancement missions, as otherwise the command would be acting as a service provider, not an end user. As the trends indicate, space systems will become ever more commonplace, so each of the geographic CINC should be able to have direct operational control over his or her own assets, once those assets have been apportioned. (Personnel in a Space Corps component command would presumably be the operators, consistent with joint employment doctrine.) The same rationale should apply for tactical warning and attack assessment (TW/AA), which today basically supports NORAD and USSTRATCOM, yet is operationally performed by USSPACECOM. Adding an extra command in the pipeline just gets in the way of the warfighters, much akin to what would happen if the CINCs did not have their own organic air, land, or sea assets. This may be

difficult to accept in today's environment where each force enhancement satellite system is a major acquisition with considerable cost and complexity and bureaucracy. Yet once *thousands* of satellites are operational, it may just seem the natural way of life.

The space control and force application missions, on the other hand, need to remain under the operational control of a warfighting CINC not focused on a geographic region, and it becomes even more efficient to combine these missions with USSTRATCOM's nuclear deterrent role, as all these missions are strategic/global in nature. This combination has the added benefit of permitting many surveillance resources such as long-range radars and surveillance satellites to accomplish both the TW/AA and space surveillance functions for the same command.[7] This also gives the missileers one boss, as today they are administratively under the control of AFSPC while operationally assigned to USSTRATCOM. A further consolidation would be to assign any national ballistic missile defense system to this combined strategic-space command, as again the surveillance resources are complementary, the outlook global, and the mission strategic in nature.

The expected increased commercialization and abundance of space launch, at least at the smaller size of the spectrum, would suggest that many of the space support functions of launch and checkout could be commercialized in the next century. Spaceplanes and air- or sea-launched boosters might also reduce the reliance on fixed ranges, while space-based assets may reduce the need for a global land-based satellite tracking and control networks. Some space tracking functions might also be civilianized, as much nonmilitary space traffic control could be performed by a space-version of the FAA. Thus, the space support

mission should be expected to be of lesser importance to the military, once ready access to space has been achieved (still a big challenge for the next twenty years, however).

Overall, this approach retains unity of command over the critical control missions, yet it clearly falls short of treating space as an Area of Responsibility (AOR) that would make USSPACECOM a geographic rather than functional unified command. Since all the terrestrial geographic CINCs rely heavily on space assets to fulfill their responsibilities, because those assets provide a presence and vantage to the terrestrial forces, and because access to space for everyone will become more readily available, the most prudent approach is to more tightly integrate space operations into each of the geographic CINC's planning. Having USSPACECOM retain total centralized control over all space assets, including the force enhancement missions, would continue to follow a command-oriented approach which would do little to improve warfighter responsiveness, while be increasingly difficult to manage (in a time of reduced personnel and budgets) as the number of assets expanded.

Bureaucratic change is always difficult, since there are always winners and losers. The perceived losers will resist the change, so one might expect, for example, that the Army and Navy would oppose giving up their roles in space acquisition and ballistic missile defense. Meanwhile, the pilot community will continue to want to lead the space forces. Perhaps only an act of Congress will be able to bring about these changes.

Notes

[1]"Coherent Space Programs Aim of Joint Service Push," *National Defense*, January 1995, 12.

[2]Maj Christian C. Daehnick, "Blueprints for the Future—Comparing National Security Space Architectures," SAAS report (Maxwell AFB, AL: School of Advanced Airpower Studies, June 1995), 2.

Notes

[3]Ibid., 14.

[4]Robert L. Butterworth, "The Case Against Centralizing Military Space," *Strategic Review*, no 24 (Summer 1996), 42.

[5]Daehnick, 15-16.

[6]Gen Howell M. Estes III, Commander, Air Force Space Command, memorandum to distribution, subject: Importance of Space and Missile Operational Experience for 13SX Officers, November 1996.

[7]One issue that would have to be resolved with this approach would be separating the defensive, non-nuclear role of NORAD from the offensive, nuclear role of USSTRATCOM. One solution would be to have two separate sub-unified commands for offensive assets (including any space weapons) and defensive assets (including any national missile defense system).

Chapter 5

Summary

We're going to realize that all the stuff we do from the air we can do from space—more effectively, faster, easier and then cheaper.

—Lt Gen Jay Kelley
Air University Commander[1]

Present Air Force doctrine makes a judgmental error by combining two distinct media into one regime for the purpose of organizational expediency. While this approach benefits the status quo bureaucracies and helps the Air Force in its struggle with the other services over who controls space, it trivializes the physical properties of the space environment and the characteristics of the systems which operate within it. A better approach is to recognize space's uniqueness and develop a doctrine exploiting its dominant attributes: direct vantage, global access, endurance, and synchronization. Employment considerations should be based on the principles of protection, standardization and centralized space control.

Future trends suggest a great proliferation of space traffic and debris, driven mainly by micro-miniaturization, commonality, and the emergence of low-cost methods of accessing space. With crowding will come conflicts requiring traffic control, along with an enforcement mechanism. Additionally, the development of directed energy weapons

can be expected to complete the transformation of warfare in the Information Age, one in which detected targets mean destroyed targets.

Space systems are most efficiently and effectively operated if all space-related acquisition and support is consolidated within a single organization run by people with a "space-mindedness" strategic viewpoint not limited to surface and near-surface operations. This organization could be either an independent U.S. Space Force, or a semi-independent Space Corps under the Air Force. Space control (including traffic control) and force projection missions, along with strategic forces and missile defense, should be the concern of a single CINCSPACE to ensure unity of command, while force enhancement missions mainly supporting the other warfighting commands should be apportioned by CINCSPACE but operated as needed by the ultimate end users. Such an approach will allow additional growth in space capabilities with a minimum amount of bureaucracy and infrastructure. More importantly, it will allow space warfighters to focus on the space environment as opposed to supporting terrestrial activities—paving the way for yet another generation of expansion as space operations move on to the moon, the libration points, and deep space.

Notes

[1]Quoted in Steven Watkins, "Is the space mission too big to handle?" *Air Force Times*, 7 October 1996, 33.

Appendix A

Flag Officers in Space Leadership Positions

Flag officers in key space-related positions, by aeronautical rating and first operational assignment, as of February 1997:

Table 4. USSPACECOM/NORAD/AFSPC Flag Officers

Position	Rank	Name	Ratings
CINC/CC	GEN	ESTES	command pilot, F4
SPJ3	BGEN	SCANLAN	master space
NJ5	BGEN	KELLY	command pilot, T38
NJ6/SPJ6/SC	BGEN	WOODWARD	master communications
CMOC/CC	MGEN	GRIME	command pilot, F4
CMOC/J3	BGEN (S)	NIELSEN	master space
CV	LGEN	CARUANA	command pilot, KC135
RC MOB	MGEN	WATSON	master space
DO	BGEN	PERRYMAN	master missile
XP	BGEN	BOONE	master missile, master space
DR	BGEN	WARD	command pilot, C141; master space
SWC CC	BGEN	MOORHEAD	command pilot, A37
14AF/CC	MGEN	VESELEY	command pilot, F111
21SW/CC	BGEN	BLAISDELL	master missile, master space
45SW/CC	BGEN	HINSON	command pilot, B52
50SW/SWC/CC	BGEN	MOORHEAD	command pilot, A37

Source: Space Command biographies taken from on-line, Internet, 28 February 1997, available from http://www.spacecom.af.mil; non-Space Command bios available using search feature on http://www.af.mil.

Table 5. Other Space-Related Flag Officers

Position	Rank	Name	Ratings
AFMC/SMC/CC	LGEN	DEKOK	master space
AFMC/SMC/CV	BGEN	CLAY	master space
AFMC/SMC/MT	BGEN (S)	WESTON	master space, master acquisition
BMDO/D	LGEN	LYLES	master space, master missile
BMDO/PO	BGEN	EMERY	command pilot, F4
NRO/CC	BGEN	LARNED	master space, master acquisition
OASAF/SS (NRO)	BGEN	MITCHELL	master space, master acquisition, senior missile
OUSD/A&T (Space Arch)	MGEN	DICKMAN	master space
SAF/AQ (Space)	BGEN	BEALE	master intelligence

Source: Space Command biographies taken from on-line, Internet, 28 February 1997, available from http://www.spacecom.af.mil; non-Space Command bios available using search feature on http://www.af.mil.

Where an officer had obtained a secondary career expertise, the primary rating is listed first.

Table 6. Number (%) of USAF Flag Officers, By Primary Career Fields

Field	US/AFSPC	Other	Total
Pilots	9 (56%)	1 (11%)	10 (40%)
Space	3 (19%)	7 (78%)	10 (40%)
Missile	3 (19%)	0	3 (12%)
Communications	1 (6%)	0	1 (4%)
Intelligence	0	1 (11%)	1 (4%)
Total	**16 (100%)**	**9 (100%)**	**25 (100%)**

Source: Space Command biographies taken from on-line, Internet, 28 February 1997, available from http://www.spacecom.af.mil; non-Space Command bios available using search feature on http://www.af.mil.

Note that more space operations generals work outside of Space Command when filling space-related positions. This suggests that while Space Command's hiring practices reflect a bias toward pilots, the space acquisition community (including NRO, BMDO, Pentagon) is more likely to put space operators in space-related assignments.

Bibliography

Air Force Doctrine Document (AFDD) 4. *Space Operations Doctrine*. 10 July 1996 (Draft).

Air Force Manual (AFM) 1-1. *Basic Aerospace Doctrine of the United States Air Force*. 2 vols., March 1992.

Air University. *Spacecast 2020: Air University into the Future.* Vols. 1-4, Air University, Maxwell AFB, AL, 22 June 1994.

Bruner, Maj William W. III, "National Security Implications of Inexpensive Space Access," SAAS report. Maxwell AFB, AL: School of Advanced Airpower Studies, June 1995.

Butterworth, Robert L. "The Case Against Centralizing Military Space," *Strategic Review*, no 24 (Summer 1996), 41-49.

"Coherent Space Programs Aim of Joint Service Push," *National Defense*, January 1995, 12-13.

Daehnick, Maj Christian C. "Blueprints for the Future—Comparing National Security Space Architectures," SAAS report. Maxwell AFB, AL: School of Advanced Airpower Studies, June 1995.

Drew, Col Dennis M. and Snow, Dr Donald M. *Making Strategy: An Introduction to National Security Processes and Problems.* Maxwell AFB, AL: Air University Press, August 1988.

Friedenstein, Lt Col Charles D. "The Uniqueness of Space Doctrine." *Air University Review* 37, no1 (November-December 1985), 13-23.

JCS Pub 1, *Joint Warfare of the Armed Forces of the United States*, 10 January 1995.

JCS Pub 3-14. *Joint Doctrine: Tactics, Techniques, and Procedures (TPP) for Space Operations*. 15 April 1992 (Draft).

Krepinevich, Andrew F. Jr. *The Military-Technical Revolution: A Preliminary Assessment*. OSD/Office of Net Assessment, July 1992.

Lupton, Lt Col David E. *On Space Warfare: A Space Power Doctrine.* Maxwell AFB, AL: Air University Press, 1988.

Mantz, Lt Col Michael R. *The New Sword: A Theory of Space Combat Power*. Maxwell AFB, AL: Air University Press, May 1995.

Middleton, Col Gordon R. *Space is a Different Place*. Air War College report. Maxwell AFB, AL: Air War College, 1992.

Myers, Col Kenneth A. *Organizing for Military Space Operations.* Air War College report, Maxwell AFB, AL, May 1986.

Myers, Col Kenneth A and Tockston, Lt Col John G. "Real Tenets of Military Space Doctrine," *Airpower Journal*, Winter 1988, 55-68.

Noyes, Harry F. III. "Air and Space Forces: The One Endures as the Other Emerges," *Airpower Journal*, Spring 1990, 62-71.

Robinson, Ernest Y., Helvajian, Henry and Janson, Siegfried W. "Small and Smaller: The World of MNT," *Aerospace America*, 34, no 9 (September 1996), 26-32.

U.S. Air Force. *Global Engagement: A Vision for the 21st Century Air Force.* Air Staff, 1996.

U.S. Air Force. *Air Force Executive Guidance.* Air Staff, October 1996 update.

U.S. Air Force Scientific Advisory Board. *New World Vistas: Air and Space Power for the 21st Century*. 12 vols. Washington DC: USAFSAB, 1995.

Watkins, Steven. "Is the Space Mission Too Big to Handle?" *Air Force Times*, 7 October 1996, 32-33.

Air Command and Staff College
Maxwell AFB, Al 36112